WHAT IS CLAIMD IS:

1. A plasma processing apparatus comprising a vacuum processing chamber, a plasma generating means including a pair of electrodes, a sample table having a sample mounting surface for mounting a sample to be processed inside said vacuum processing chamber, and a evacuating means for evacuating said vacuum processing chamber, which further comprises:

a high frequency electric power source for applying a high frequency electric power of a VHF band from 30 MHz to 300 MHz between said pair of electrodes; and

a magnetic field forming means for forming any one of a static magnetic field and a low frequency magnetic field in a direction intersecting an electric field generated between said pair of electrodes and the vicinity by said high frequency electric power source;

wherein an electron cyclotron resonance region being formed between said pair of electrodes by said magnetic field and said electric field.

2. A plasma processing apparatus comprising a vacuum processing chamber, a plasma generating means including a pair of electrodes, a sample table for mounting a sample to be processed inside said vacuum processing chamber and also serving as one of said electrodes, and a evacuating means for evacuating said vacuum processing chamber, which further comprises:

a high frequency electric power source for applying an electric power of a VHF band from 50 MHz to 200 MHz between said pair of electrodes; and

a magnetic field forming means for forming any one of a static magnetic field and a low frequency magnetic field not weaker than 17 gausses and not stronger than 72 gausses in a direction intersecting an electric field generated between said pair of electrodes and the vicinity by said high frequency electric power source;

wherein said magnetic field forming means being set so that a portion where a component of said magnetic field in a direction along the surface of said sample table becomes maximum is brought to a position in the opposite side of said sample table from the middle of said pair of electrodes;

an electron cyclotron resonance region being formed between said pair of electrodes by said magnetic field and said electric field.

3. A plasma processing apparatus according to any one of claim 1 and claim 2, wherein

intensity of the magnetic field formed by said magnetic field forming means is set so that a component of the magnetic field parallel to the surface of said sample table is not stronger than 30 gausses on the surface of said sample table.

4. A plasma processing apparatus comprising a vacuum processing chamber, a plasma generating means including a pair of electrodes, and a sample table for mounting a sample to be processed inside said vacuum processing chamber and also serving as one of said electrodes, which further comprises:

a evacuating means for evacuating said vacuum processing chamber to 0.4 Pa to 4 Pa;

a high frequency electric power source for applying an electric power of a VHF band from 30 MHz to 300 MHz between said pair of electrodes; and

a magnetic field forming means for forming any one of a static magnetic field and a low frequency magnetic field not weaker than 10 gausses and not stronger than 110 gausses in a direction intersecting an electric field between said pair of electrodes and in the vicinity;

said electrodes being composed of a first electrode connected to said high frequency electric power source and a second electrode also serving as said sample table connected to a bias electric power source for controlling ion energy, a distance between said pair of electrodes being 30 to 100 mm;

an electron cyclotron resonance region being formed at a position within a range from the surface of said first electrode to the side of said first electrode from the middle of said pair of electrodes by interaction of said magnetic field and an electric field produced by said

high frequency electric power source.

5. A plasma processing apparatus according to any one of claims 1, 2 and 4, wherein

density and/or direction of said magnetic field formed by said magnetic field forming means are adjusted so that said cyclotron resonance effect of electrons becomes larger in a portion within a range from the periphery of said sample to the outer side of the periphery than in the center of said sample, thereby the plasma density being made uniform in positions corresponding to all over the surface of said sample mounting surface.

6. A plasma processing apparatus according to claim 4, wherein

said magnetic field forming means comprises a core which continuously changes distance of said cyclotron resonance region to said sample by eccentrically rotating to the center of said sample surface to change said magnetic field.

7. A plasma processing apparatus comprising a vacuum processing chamber, a plasma generating means including a pair of electrodes, a sample table having a sample mounting surface for mounting a sample to be processed inside said vacuum processing chamber, and a evacuating

means for evacuating said vacuum processing chamber, which further comprises:

a high frequency electric power source for applying an electric power of a VHF band from 30 MHz to 300 MHz between said pair of electrodes and between a first electrode and a wall portion of said processing chamber, said electrodes being composed of said first electrode connected to said high frequency electric power source and a second electrode also serving as said sample table and the wall portion of said grounded processing chamber arranged in the outer peripheral side of said first electrode;

a magnetic field forming means for forming any of static magnetic fields and low frequency magnetic fields not weaker than 10 gausses and not stronger than 110 gausses in such a manner as to cancel each other out near the central portion of said processing chamber and superpose each other in the periphery and the outer side of said processing chamber;

an electron cyclotron resonance region being formed at a position within a range from the peripheral portion of said sample mounting surface to a portion near the outer side by interaction of said magnetic field and an electric field produced by said high frequency electric power source.

8. A plasma processing apparatus according to claim 7,

wherein

said magnetic field forming means comprises a plurality of coils arranged around said processing chamber in such a manner as to cancel each other out near the central portion of said sample and superpose each other in the periphery and the outer side of said sample.

9. A plasma processing apparatus according to claim 4, wherein

said bias electric power source for controlling ion energy applies a pulse bias having a period of 0.2 to 5 μm and a duty at positive direction pulse portion not larger than 0.4 to said sample through a capacitor element.

10. A plasma processing apparatus according to any one of claims 1, 2 and 4, which further comprises:

an electrostatic attracting means for holding said sample onto said sample table by an electrostatic attracting force;

a pulse bias applying means connected to said sample table and for applying a pulse bias voltage to said sample table; and

a voltage suppressing means for suppressing a voltage rising generated by applying said pulse bias voltage corresponding to an electrostatic attracting capacity of said electrostatic attracting means.

11. A plasma processing apparatus according to claim 10, wherein

said voltage suppressing means is designed so that voltage change due to an electrostatic attracting film of said electrostatic attracting means during one cycle of pulse is suppressed to one-half of said pulse bias voltage.

12. A method of plasma-processing a sample using a plasma processing apparatus comprising a vacuum processing chamber, a plasma generating means including a pair of electrodes, a sample table for mounting a sample to be processed inside said vacuum processing chamber and also serving as one of said electrodes, and a evacuating means for evacuating said vacuum processing chamber, the method comprising the steps of:

evacuating inside said vacuum processing chamber by said evacuating means;

forming any one of a static magnetic field and a low frequency magnetic field not weaker than 10 gausses and not stronger than 110 gausses in a direction intersecting an electric field between said pair of electrodes by a magnetic field forming means;

forming an electron cyclotron resonance region between said both electrodes by interaction of said magnetic field and an electric field generated by a high frequency electric power source by applying an electric power of a VHF band from 30 MHz to 300 MHz between said

pair of electrodes using said high frequency electric power source; and

processing said sample by a plasma produced by said cyclotron resonance of electrons.

13. A method of plasma-processing a sample using a plasma processing apparatus comprising a vacuum processing chamber, a sample table for mounting the sample to be processed inside said vacuum processing chamber, and a plasma generating means including a pair of electrodes, wherein

said electrodes being composed of a first electrode connected to said high frequency electric power source and a second electrode also serving as said sample table connected to a bias electric power source for controlling ion energy, a distance between said pair of electrodes being 30 to 100 mm;

the method comprising the steps of:

evacuating said vacuum processing chamber to 0.4 Pa to 4 Pa by a evacuating means;

forming any one of a static magnetic field and a low frequency magnetic field not weaker than 10 gausses and not stronger than 110 gausses in a direction intersecting an electric field between said pair of electrodes by a magnetic field forming means;

forming an electron cyclotron resonance region between said both electrodes by interaction of said

magnetic field and an electric field generated by a high frequency electric power source by applying an electric power of a VHF band from 30 MHz to 300 MHz between said pair of electrodes using said high frequency electric power source; and

processing said sample by a plasma produced by said cyclotron resonance of electrons.

14. A plasma processing apparatus comprising a vacuum processing chamber, a sample table for mounting a sample to be processed in said vacuum processing chamber, and a plasma generating means including a high frequency electric power source, which further comprises:

an electrostatic attracting means for holding said sample onto said sample table by an electrostatic attracting force; and

a pulse bias applying means for applying a pulse bias voltage to said sample;

said high frequency electric power source applying a high frequency voltage of 10 MHz to 500 MHz, said vacuum processing chamber being depressurized to 0.5 to 4.0 Pa.

15. A plasma processing apparatus comprising:

a pair of electrodes opposite to each other, one of the electrodes mounts a sample;

a gas introducing means for introducing an etching gas into an environment in which said sample is placed;

an evacuating means for evacuating and depessurising said environment to a pressure condition of 0.5 Pa to 4.0 Pa;

a high frequency electric power source for applying a high frequency voltage of 10 MHz to 500 MHz to said pair of opposite electrodes;

a plasma generating means for forming said etching gas into a plasma under said pressure condition; and a pulse bias applying means for applying a pulse bias voltage to said one of the electrodes during etching said sample;

thus an insulator film in said sample being plasma-processed.

16. A plasma processing apparatus comprising a vacuum processing chamber, a sample table for mounting a sample to be processed in said vacuum processing chamber, and a plasma generating means including a high frequency electric power source, which further comprises:

an electrostatic attracting means for holding said sample onto said sample table by an electrostatic attracting force;

a pulse bias applying means connected to said sample table and for applying a pulse bias voltage to said sample; and

a voltage suppressing means for suppressing a voltage rising generated by applying said pulse bias voltage

corresponding to an electrostatic attracting capacity of said electrostatic attracting means;

said voltage suppressing means being designed so that voltage change due to an electrostatic attracting film of said electrostatic attracting means during one cycle of pulse is suppressed to one-half of said pulse bias voltage.

17. A plasma processing apparatus comprising:

a pair of electrodes opposite to each other having a gap between the electrodes of 10 mm to 50 mm;

an electrostatic attracting means for holding a sample onto one of said electrodes by a electrostatic attracting force;

a gas introducing means for introducing an etching gas into an environment holding said sample;

an evacuating means for evacuating and deperssurizing said environment to a pressure condition of 0.5 Pa to 4.0 Pa;

a plasma generating means for forming said etching gas into a plasma under said pressure condition by a high frequency electric power of 10 MHz to 500 MHz; and

a pulse bias applying means for applying a pulse bias voltage to said one of electrode mounting said sample;

thus an insulator film in said sample being plasma-processed.

18. A plasma processing apparatus according to any one of

claims 16 and 17, which further comprises:

a voltage suppressing means for suppressing a voltage rising generated by applying said pulse bias voltage corresponding to an electrostatic attracting capacity of said electrostatic attracting means;

said voltage suppressing means setting a period of said pulse bias voltage so that voltage change due to an electrostatic attracting film of said electrostatic attracting means during one cycle of pulse is suppressed to one-half of said pulse bias voltage.

19. A method of plasma-processing comprising the steps of:

placing a sample on one of electrodes provided in a vacuum processing chamber;

holding said sample onto said electrode by an electrostatic attracting force;

introducing a processing gas into an environment in which said sample is placed;

evacuating and evacuating said environment to a pressure condition for processing said sample;

forming said processing gas into a plasma under said pressure condition;

processing said sample by said plasma; and

applying a pulse bias voltage to said sample.

20. A method of plasma processing comprising the steps

of:

placing a sample on one of a pair of electrodes opposite to each other having a gap of 10 mm to 50 mm;

holding said placed sample onto said electrode by an electrostatic attracting force;

introducing a processing gas into an environment in which said sample is placed;

evacuating said environment to a pressure condition of 0.5 Pa to 4.0 Pa;

forming said processing gas into a plasma under said pressure condition by applying a high frequency electric power of 10 MHz to 500 MHz;

etching said sample by said plasma; and

applying a pulse bias voltage to said one of electrodes during etching;

thereby, an insulator film in said sample being plasma-processed.

21. A method of plasma processing comprising the steps of:

placing a sample on one of electrodes provided in a vacuum processing chamber;

holding said sample onto said electrode by an electrostatic attracting force;

introducing an etching gas into an environment in which said sample is placed;

evacuating and evacuating said environment to a

pressure condition for processing said sample;

forming said etching gas into a plasma under said pressure condition;

etching said sample by said plasma; and

applying a pulse bias voltage to said sample;

suppressing voltage change due to an electrostatic attracting film of said electrostatic attracting means during one cycle of pulse to one-half of said pulse bias voltage during applying said pulse bias voltage.

22. A method of plasma processing comprising the steps of:

placing a sample on one of electrodes opposite to each other;

holding said placed sample onto said electrode by an electrostatic attracting force;

introducing an etching gas into an environment in which said sample is placed;

forming said etching gas into a plasma;

etching said sample by said plasma; and

applying a pulse bias voltage having a pulse width of 250 V to 1000 V and a duty ratio of 0.05 to 0.4 to said one of electrodes during etching;

thereby an insulator film in said sample being plasma-processed.

23. A plasma processing apparatus comprising a vacuum

processing chamber, a sample table for mounting a sample to be processed in said vacuum processing chamber, and a plasma generating means, which further comprises:

an electrostatic attracting means for holding said sample onto said sample table by an electrostatic attracting force;

a bias applying means for applying a bias voltage to said sample;

a radical supplying means having a means decomposing a gas for generating radicals in advance and for supplying a required amount of the radicals to said vacuum processing chamber;

a means for supplying a gas for generating ions to said vacuum processing chamber; and

a plasma generating means for generating a plasma in said vacuum processing chamber;

wherein SiO_2 being used as said sample.

24. A plasma processing apparatus comprising a vacuum processing chamber, a sample table for mounting a sample to be processed in said vacuum processing chamber, and a plasma generating means, which further comprises:

an electrostatic attracting means for holding said sample onto said sample table by an electrostatic attracting force;

a pulse bias applying means for applying a pulse bias voltage to said sample;

a radical generating plasma supplying means for forming a gas for generating radicals into a plasma in advance and for supplying a required amount of the radicals to said vacuum processing chamber; and

said plasma generating means for supplying a gas for generating ions to said vacuum processing chamber and for generating a plasma in said vacuum processing chamber;

wherein SiO_2 being used as said sample.

25. A plasma processing apparatus comprising a vacuum processing chamber, a sample table for mounting a sample to be processed in said vacuum processing chamber, and a plasma generating means including a high frequency electric power source, which further comprises:

an electrostatic attracting means for holding said sample onto said sample table by an electrostatic attracting force;

a pulse bias applying means for applying a pulse bias voltage to said sample;

a radical generating plasma supplying means for forming a gas for generating radicals into a plasma in advance and for supplying a required amount of the radicals to said vacuum processing chamber; and

said plasma generating means for supplying a gas for generating ions to said vacuum processing chamber and for generating a plasma in said vacuum processing chamber;

wherein said high frequency electric power source

applying a high frequency voltage of 10 MHz to 500 MHz, said vacuum processing chamber being depressurized to 0.5 to 4.0 Pa.

26. A plasma processing apparatus comprising a vacuum processing chamber, a sample table for mounting a sample to be processed in said vacuum processing chamber, and a plasma generating means, which further comprises:

an electrostatic attracting means for holding said sample onto said sample table by an electrostatic attracting force;

a radical generating plasma supplying means for forming a gas for generating radicals into a plasma in advance and for supplying a required amount of the radicals to said vacuum processing chamber;

said plasma generating means for supplying a gas for generating ions to said vacuum processing chamber and generating a plasma;

a pulse bias applying means connected to said sample table and for applying a pulse bias voltage to said sample table; and

a voltage suppressing means for suppressing a voltage rising generated by applying said pulse bias voltage corresponding to an electrostatic attracting capacity of said electrostatic attracting means.

27. A plasma processing apparatus comprising a vacuum

processing chamber, a sample table for mounting a sample to be processed in said vacuum processing chamber, and a plasma generating means, which further comprises:

an electrostatic attracting means including an electrostatic attracting film provided in said sample table and for holding said sample onto said sample table by an electrostatic attracting force;

a radical generating plasma supplying means for forming a gas for generating radicals into a plasma in advance and for supplying a required amount of the radicals to said vacuum processing chamber;

said plasma generating means for supplying a gas for generating ions to said vacuum processing chamber and generating a plasma;

a pulse bias applying means connected to said sample table and for applying a pulse bias voltage to said sample table; and

a voltage suppressing means for suppressing a voltage generated between the both ends of said electrostatic attracting film as said pulse bias voltage is applied;

wherein said voltage suppressing means suppressing a voltage of the electrostatic attracting film of said electrostatic attracting means to a voltage not higher than one-half of said pulse bias voltage.

28. A method of plasma-processing comprising the steps of:

placing a sample on one of a pair of electrodes opposite to each other;

holding said placed sample onto said electrode by an electrostatic attracting force;

forming a gas for generating radicals into a plasma in advance and supplying a required amount of the radicals into an environment in which said sample is placed and held;

supplying a gas for generating ions to said environment;

evacuating and evacuating said environment to a pressure condition of 0.5 Pa to 4.0 Pa;

forming said supplied gas for generating ions into a plasma under said pressure condition by applying a high frequency electric power of 10 MHz to 500 MHz to said opposite electrodes;

etching said sample by said plasma; and

applying a pulse bias voltage to said one of electrodes during etching;

wherein SiO_2 being used as said sample.

29. A method of plasma-processing comprising the steps of:

placing a sample on one of electrodes provided in a vacuum processing chamber;

holding said sample onto said electrode by an electrostatic attracting force;

forming a gas for generating radicals into a plasma in advance and supplying a required amount of the radicals into an environment in which said sample is placed and held;

supplying a gas for generating ions to said environment;

forming said supplied gas for generating ions into a plasma under said pressure condition by applying a high frequency electric power of 30 MHz to 100 MHz to said opposite electrodes;

processing said sample by said plasma; and

applying a pulse bias voltage to said sample;

wherein SiO_2 being used as said sample.

30. A method of plasma-processing comprising the steps of:

placing a sample on one of electrodes provided in a vacuum processing chamber;

holding said sample onto said electrode by an electrostatic attracting force;

forming a gas for generating radicals into a plasma in advance and supplying a required amount of the radicals into an environment in which said sample is placed and held;

supplying a gas for generating ions to said environment;

evacuating and evacuating said environment to a

pressure of processing said sample;

forming said supplied gas for generating ions into a plasma under said pressure condition;

processing said sample by said plasma; and

applying a pulse bias voltage to said sample;

wherein a voltage of said electrostatic attracting means being set to a voltage not higher than one-half of said pulse bias voltage.--

31. A method of plasma-processing comprising the steps of:

placing a sample on one of electrodes opposite to each other provided in a vacuum processing chamber;

holding said sample onto said electrode by an electrostatic attracting force;

forming a gas for generating radicals into a plasma in advance and supplying a required amount of the radicals into an environment in which said sample is placed and held;

supplying a gas for generating ions to said environment;

evacuating and depressurerizing said environment to a pressure of 0.5 Pa to 4.0 Pa;

forming said supplied gas for generating ions into a plasma under said pressure condition by applying a high frequency electric power of 30 MHz to 100 MHz to said opposite electrodes;

processing said sample by said plasma; and

applying a pulse bias voltage to said sample.

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